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ABSTRACT

This document presents cross-sectional and longitudinal data relating the time required to read orally 50 unrelated letters, 50 unrelated words, and 100 words in text among first to sixth grade children and adults. Results include concurrent correlation between letter, word, and text times ranging between .18 and .92 with a median of .77. Longitudinal correlations between grades two and six ranged from .21 to .96 with a median of .78 indicating a high level of developmental stability and strong relationships between the abilities to read letters or words rapidly at an earlier age and reading text rapidly at a later age. Multiple regression analyses indicate that letter time variance is associated with a median of 46 percent of text time variance, while additional skills affecting word time variance is associated with a median of 27 percent of text time variance between grades two and six. These and the remaining results may be interpreted to indicate the existence of a developmental reading speed ability which is not primarily dependent on word identification or context-using skills. (Author/SW)

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READING READINESS - A MAJOR RESEARCH PROBLEM

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READING READINESS - A MAJOR RESEARCH PROBLEM

The major research hypothesis which I will present today is simply this:

That the age at which children become ready to learn to read adequately within the course of one to two years varies from four to ten.

By "read", I mean being able to understand by reading language which one can understand if the language is presented aurally.

By "learn to read", I mean learning within the context of our typical school environment - in which a single teacher is responsible for a group of 20 to 35 children.

I realize that there are a number of children who suffer from defects affecting the capacity to read which do not disappear with maturation. However, I believe that research focussed on the developmental hypothesis just stated would demonstrate that these children represent a substantially smaller proportion of the total population than the ten to fifteen percent or so now described as dyslexic (ref. Templeton, A.B., et. al., 1969). In short, I am suggesting that a significant proportion of children who now experience great difficulty with reading do so because they are being asked at age six to do what they will not be able to do until they are seven, eight, or even older.

This is hardly a radical hypothesis for most teachers. Yet surprisingly, I have found almost no research being conducted on this hypothesis. Instead, the literature teems with studies concerned with how to teach failing first graders (ref. first grade studies), or how to reduce the failure rate with six year olds, and a growing interest in reading instruction for still younger children.

I have come to this hypothesis as a result of a series of studies in which a very simple and very old measure successfully identified failing readers and slow-progressing readers. This measure has the characteristics of a developmental variable - all children improve with age and those who show greater relative ability when young also show greater relative ability when older - in short the measure

demonstrates developmental stability (Bloom, 1964). The measure, which I have borrowed from James McKeen Cattell (1886), consists simply of the time required to read orally 50 randomly ordered letters typed on a sheet of paper. I will have more to say on these findings and their implications later in this paper. First however, I'd like to turn to the concept of readiness. This will be followed by a brief review of what we now know about early reading - both children who learn to read before six and programs for teaching reading before six. I will then describe some recent findings on predicting reading failure, and the role of age as a predictor. Following these will be a discussion of my studies of oral reading speeds, and a look at neurophysiological maturation. Finally, I will discuss some of the research directions suggested by the problem of readiness, and some thoughts about the dangers of overlooking a wide range of differences in readiness, and about why our society has continued to do so.

The Concept of Readiness

There have been two broad approaches to the problem of readiness. One views readiness as a problem of identifying "requisite antecedant behaviors" (e.g. Sapon, 1971, and all approaches which stress remedial correction of "deficits or lags"). In this approach, lack of "readiness" is usually viewed as missing skills which a child failed to acquire by the age at which instruction in a more complex skill - such as reading - is begun. It is frequently assumed that this failure is due to lack of opportunity or prior instruction, rather than lack of capacity to acquire these prerequisite skills. Thus we have a very wide variety of readiness programs which are designed to eradicate individual differences. Experience with these programs has been less than overwhelmingly successful.

The other approach to readiness is perhaps best summarized by Ausubel and Sullivan (1970, p. 97):

"The crucial issues in other words are whether such early learning is reasonably economical in terms of the time and effort involved, and whether it helps children developmentally in terms of their total educational careers."

This viewpoint suggests that there is not a specific age for learning a given skill nor even a specific age for each child, but rather that for each child, the lower the age at which teaching a specific skill is initiated, the greater will be the time and effort required for mastery. In other words, a particular child who could learn to read at age six in 180 days of group instruction in a typical first grade class might require more individualized instruction and 250 days to attain the same skill at age 5, and still more individualized instruction plus more time at age 4. The example is, of course, purely hypothetical. However, it is consistent with the small amount of evidence available (see section on Early Reading Instruction).

These two approaches to readiness - requisite antecedant behaviors, and time to master as a function of age - are by no means mutually exclusive. However, adherents of the time-to-master approach have often stressed physiological maturation (e.g. Ilg and Ames, 1965) rather than unlearned skills which could be taught earlier.

Early Reading I - Children Who Read Early: One of the major arguments against notions of reading readiness and for early reading instruction has been the success of children who read before grade one. That these children are successful in elementary school has been clearly documented by Durkin (1966). However, to move from this observation to the conclusion that early reading would be a boon for all is unwarranted. We already know that early excellence or advancement in most aspects of development is associated with later advancement (Bloom, 1964). This is as true of height, which is largely governed by genetic factors as it is of various types

of school performance which are clearly more subject to environmental factors.

Durkin's research stresses similarities between her early readers and I.Q. matched peers. The only major reported difference was a strong preference for quiet and often solitary activities. In general, Durkin's early readers were of above average intelligence although there were some children in the 90-100 range. More recently, Briggs and Elkind (1973) have found that kindergarteners who were reading differed from age and I.Q. matched non-readers on conservation tasks and accuracy at matching familiar figures. This material will be discussed at greater length in Prof. Elkind's presentation.

The existance of some early readers in no way supports the conclusion that all children would benefit from early reading instruction. It does suggest that the range of ages at which children are ready to profit from reading instruction is wider than the automatic approach of starting at grade one implies.

Early Reading II - Experiments with Preschool Reading Instruction: It is obvious that any argument that children are "unready" to learn a particular skill at a particular age or stage of development can be readily disproven simply by successfully teaching such children the skill in question. What in fact are the findings of studies of preschool reading instruction? Summarizing a number of current studies, Fowler (1971) suggested that a mental age of 4 appeared to be prerequisite for any success. Furthermore, the maximum level of attainment by even those four year olds who did "read" appears to be mastery of a relatively small number of sight-words and/or sound-spelling relationships.

Results from Fowler's own research (1971), and from Durkin's attempt to adapt her early reader findings to a classroom program are consistent with the conclusion that very few four year olds are able to learn to read as defined in this paper. Working daily with groups of 4 to 8 bright children (average initial age 4 years 3 months, average I.Q. 122), Fowler and his teachers succeeded in moving 69 percent

of the 109 children part or all of the way through a reading program. By the end of six months 28 percent of the initial group had mastered as many as 36 to 56 words. One had progressed considerably further. The average for all children was 31 words. One wonders what could be accomplished by teachers of six or seven year olds with an overall teacher-child ratio of one to seven enjoyed by Fowler's teachers.

Durkin (1970) worked with two small classes of four year olds (each had 18 children) and with the same children during their fifth year (average I.Q. 114). The children worked on reading in groups of nine for twenty minutes a day. An assistant took care of the children who were not in the reading group. By the end of the first year, boys could identify an average of 24 words while girls were up to 35 words. By the end of the second year of the study, the average numbers of words identified were 109 for boys and 143 for girls. A standard deviation of 42 words suggests wide variation among the children.

Thus, following two years of reading instruction under more optimal conditions than kindergarten and first grade teachers enjoy, it is clear that the large majority of Durkin's children were not yet reading independently.

A vastly larger project of Becker and Engelmann's (1974) provides information on the longer term implications of early reading instruction. Working with a teacher plus two aides in each classroom and using a standardized, code-emphasis reading program (DISTAR), Becker and Engelmann found that after first grade children who had begun their program in kindergarten were about half a year ahead of those starting their program in grade one based on Metropolitan Achievement Test Reading performance (grade equivalents of 2.28 vs. 1.78).[1] Another cohort of children, tested at the end of third grade, differed by 0.4 years (grade equivalents 3.33 vs. 2.91).[1] Again, extra effort in kindergarten yields substantially smaller gains (probably

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[1] Larger initial gains and better later performance were observed in W.R.A.T.

with only a portion of the class) than would be expected with older children and less effort.

Predicting Reading Performance

The work of de Hirsch and her associates (de Hirsch, Jansky, and Langford, 1966; Jansky and de Hirsch, 1972) using most known effective predictors of success in learning to read suggests several important conclusions about characteristics of successful predictors:

1. Most of the more effective predictors are maturation sensitive - i.e. these measures were significantly lower for younger kindergarteners than for older kindergarteners (de Hirsch et. al., 1966).
2. Effective prediction involves assessing several quite different areas of competence - no one of which alone accounts for a very large proportion of reading achievement variance in grade two. These areas are: oral language, pattern matching, visuo-motor organization, and pattern memory (Jansky and de Hirsch, 1972, p. 71).
3. Half of the thirty percent of children in the first de Hirsch study who were failing completely at the end of grade one reached normal levels of performance by the end of grade two (de Hirsch et. al., 1966, pp. 45-50). The second and much larger study (401 vs. 53 children) did not report first grade data. The overall failure rate in the second study was twice the rate in the first study (Jansky and de Hirsch, 1972, p. 53).

On the basis of the larger study (n = 401), Jansky and de Hirsch identified five tests which yield a multiple correlation of .69 with second grade reading performance and which identified over 75 percent of the grade two failing readers plus incorrectly predicting failure for 25 percent of those attaining average or better performance by grade two. These tests included: picture naming and the

Binet Sentence Memory subtest (both of which lead on their oral language factor), letter naming (oral language and pattern memory factors), plus the Bender Visuo-Motor Gestalt (visuo-motor factor) and the Gates Word Matching subtest (pattern matching factor).

Age and the Prediction of Reading Performance

The relationship between chronological age and reading success deserves consideration in a paper on "readiness". In the Jansky-de Hirsch studies, as well as in many other studies of reading or early reading performance, chronological age has very low correlations with performance. In the Jansky-de Hirsch study, for example, the correlation between grade two reading scores and age was .14. This low correlation between age and reading performance has often been taken as evidence that readiness for reading instruction is not maturational.

There are, however, several alternative explanations for the finding that age and reading performance have a low correlation.

First, the range of ages sampled in these studies is probably too narrow to pick significant age-related correlations. For example, an r of .34 between height and age was obtained for a sample of 100 six year olds (calculated from data provided by Dearborn, Rothway, and Shuttleworth, 1938). For weight, an r of .05 was obtained for 50 six year olds. Thus failure to find large correlations between age and reading performance when twelve month age ranges are considered does not prove a lack of maturational elements in reading.

Secondly, as de Hirsch et. al. (1966) indicated, there are a number of quite different capacities involved in reading readiness. Most measures of these capacities are quite age sensitive. However, the capacities are not strongly related to one another (see factor analysis in Jansky and de Hirsch, 1972) and no one capacity accounts for a large proportion of reading performance variance. This combination

of circumstances should again result in a relatively low relationship between chronological age and reading readiness, without ruling out the operation of maturational factors in reading readiness.

It should be noted that de Hirsch and her associates' kindergarten tests have succeeded in accounting for only half of the total reading performance variance at the end of grade two. Some of the unpredicted variance is attributable to reliability problems and some, no doubt, to teacher and classroom group differences as well as extra-school environmental differences which intervene between ages five and seven. Another problem in prediction may include the failure of the de Hirsch procedures to assess potential for learning rather than skills acquired by the age of testing. In the preliminary study, several attempts were made to do this with mini-learning tasks. The highest single test-to-later-reading performance correlation was obtained with one of these techniques - r = .48. However, in the main study, this test proved less powerful. It may be that insufficient items (just two) caused this problem.

Still another problem with the de Hirsch-Jansky tests, and to the best of my knowledge all other reading readiness tests, is their failure to assess speed of serial discrimination and serial identification. The importance of this capacity will be taken up in the next section.

Rapid Item Identification as a Possible Maturational Variable Affecting Reading Performance

As I mentioned at the beginning of this paper, the ability to rapidly identify a number of letters appears to be a critical factor in successful reading. I have found that the rate at which elementary school children can read a string of letters correlates around .70 with the rate of reading simple text and around .60 with Metropolitan Achievement Test scores (Biemiller, 1974a). I have also found that at the end of second grade, children who read letters at a rate of 60 letters per

minute or slower seem destined for serious reading problems in the next few years, while those who can read letters at a rate of 75 letters per minute or faster are able to "read" as I have defined reading by the end of grade three or four (Biemiller, in press).

Why should the speed of letter reading be such a sensitive index and predictor of reading performance? The reason is simply that letter speed is highly associated with text speed. A child must attain a fairly adequate text speed before he can read adequately. Smith and Holmes (1971) notes that until a speed of 150-200 words per minute is attained, the short term memory is incapable of holding a sufficient number of words to allow meaningful processing into long term memory, comprehension, or whatever term one prefers for understanding.

The significance of the strong relationship between rates for reading unrelated letters and rates for reading text is that the rate of reading unrelated letters cannot be influenced by many of the variables thought significant for comprehension and speed - notably use of semantic context and grammar, and use of higher-order units (Gibson, 1965) or sequential dependencies (Smith, 1969) within words. All of the skills I have just mentioned are probably necessary for adequate reading. However, they are all dependent upon the identification of enough letters or letter features (Smith, 1969) to allow processing on the basis of prior information or "structure". Furthermore, adequate speed is dependent on the physiological capacity to process visual information into verbal form (whether overt or internalized). I do not know where in this process some children are able to proceed faster than others. There is a small amount of evidence suggesting that differences between poor and able readers may not be at the levels of feature discrimination or pattern recognition, but rather at the level of identification or other tasks which depend on prior recognition of patterns (Spring, 1971; Katz and Wicklund, 1971).

The letter speed variable, while showing growth from grade one to adulthood (from 50 to 200 letters per minute in my studies) may not be highly subject to modification through training. I have found that some children in grades two through four can achieve short term gains on the order of 25 percent. However, others do not. It is not clear whether these gains are maintained or that they significantly affect general reading skill. I have also compared one second grade DISTAR class with comparable children from several traditional classes. The DISTAR program stresses speed in a number of exercises which are used regularly. Despite two years of this experience, there was absolutely no difference in letter or text reading rates between the DISTAR children and their peers (Biemiller, 1974b). These preliminary efforts are far from proof that speed is uninfluenceable. But they have been discouraging.

Neurophysiological Maturation

My findings have indicated that a difference of .20 seconds per response seems to have major implications for successful reading. Differences of these small magnitudes suggested to me the possibility that physiological differences may in part be involved in readiness for successful reading. In making a brief review of human neurophysiological development, I have found that there are indeed maturational processes occurring in the brain well after the age of six. Furthermore, these differences are directly related to the efficiency of neural transmission (Tanner, 1970).

The process of myelination - an aspect of the maturing of a nerve cell - continues in the reticular formation, the great cerebral commissures, the corpus callosum and various association areas until age ten or later (much later in the case of association areas) (Yakovlev and Leccurs, 1967). The reticular formation is thought by many to be involved in the process of attention (Berlyne, 1960). The commissures and corpus callosum are structures which bridge the two hemispheres of

the brain. The potential significance of later maturation in these structures would appear obvious in light of recent growing interest in the differentiated functions of the brain hemispheres. An example is Spervy's observation, described by Pines (1974) of the reading function of a patient with a completely severed corpus callosum:

> "....whenever he was faced with a page of printed matter, W.J. could read only the words in the right half of his visual field, which projected to his left hemisphere....Reading thus became very difficult and tiring for him."

How much this sounds like a description of the majority of six year olds and a large proportion of seven year olds.

Not only is the development of myelination not complete by the age of six, but many structural changes continue to occur in the brain up to and after that age. There is growth of dendrites (branches of neurons) (Tanner, 1970) and changes in surface area and fissuration of the cortex. The occipital lobe (associated with recognition functions) shows moderate increases in fissuration while the temporal lobe (hearing, and visual discrimination of form) increases rapidly in surface area and fissuration between two and six years (Turner, 1948, 1950). In view of the normal range of variability in development, it seems to me highly probable that individual differences in the maturation of these structures will range over one or two years or more.

It must be emphasized that rough associations between the maturation of the brain and the observed increase of difficulties in learning to read encountered by children as the age of instruction is reduced are far from proof that particular aspects of neurological development are implicated in reading readiness. On the other hand, these findings are certainly consistent with the view that there is a significant biological maturational component involved in the inability of large

numbers of preschool children and substantial numbers of early elementary school children to master reading. As Tanner (1970, p. 123) says in conclusion to a review of cerebral cortex development:

> "The stages of mental functioning described by Piaget and others have many of the characteristics of developing brain or body structures, and the emergeance of one stage after another is very likely dependent on (i.e. limited by) progressive maturation and organization of the cerebral cortex."

Implications for Research

1. Early Reading: Those who would undertake studies of reading instruction with children under six should be sensitive to and report clearly the range of differences occurring with their pupils. They should also examine carefully whether those children who do not progress significantly during their early instruction in fact show any later benefits. The observed later gains of groups of children who have received kindergarten reading instruction may be entirely attributable to the third or half of a group which actually demonstrated learning during the kindergarten or preschool year. Finally, more attention should be paid to which subskills of reading can profitably and pleasantly be made at younger ages and whether early learning of skills is beneficial later on. It is my impression, for example, that "phonics" skills are more readily acquired by young children than general sight reading at adequate speeds.

2. Late Reading: We see a number of experiments concerned with lowering the age at which reading instruction might be begun. Very few North Americans have tried the opposite experiment - raising the age at which reading instruction is begun, despite the fact that this is common practice in many parts of the world including Iceland (which has the world's highest literacy rate), Norway, Sweden,

and many of the east European countries. Douglass (1969) has suggested that the practice of beginning reading later in Norway, along with half-day instruction and a simpler spelling to sound system may be responsible for the relatively low incidence of reading failure in that country. It would be particularly desireable to try late reading combined with the low teacher-child ratios normally employed in early reading studies. Criteria should include both reading performance one, two, and three years after initiation of reading instruction and also attempts to determine whether the frustration and expectations of failure commonly experienced by many children in our current reading programs are reduced.

3. Slow Starters: The observations of de Hirsch et. al. regarding children who made essentially no progress in first grade while "catching up" in second are by no means unique for most teachers. Study of such children, of means of identifying them early, and of the degree to which various components of their reading instruction prior to "taking off" was actually beneficial would be most useful. It is, in my view, a plausible hypothesis that these children in fact gain very little from their reading instruction experience until they begin to acquire skills and reading vocabulary quickly. Chall's (1967) observation that many children actually read only a few words a day in the course of their reading instruction is consistent with this view.

4. Reading Readiness; Prerequisite Capacities: Further work along the lines of de Hirsch and her associates would appear fruitful, particularly if guided by hypotheses that might be generated from research on neurological development, scanning speed, cognitive and linguistic competence, and word identification skills (see Kavanaugh and Mattingly, 1972 for reviews of research on this subject). The question of whether prerequisite capacities are subject to training, and whether training in some capacities is appropriate if other prerequisites are largely maturational deserves attention. Also, methods of monitoring the more maturational

aspects of development on a frequent basis (rather than the usual annual testing schedules now used) would assist teachers with children who are not "ready" in September but may become so, often quite suddenly, two or three months later.

5. Reading Readiness; Emotional Aspects: I have not dealt in this paper with emotional problems related to reading. However, they obviously play a role, and one that is often linked to lowered capacity. De Hirsch et. al (1966) found that clinical ratings of "ego strength" and "work attitude" provided stronger predictions of later reading performance than 30 of 35 other measures (r's of .48 and .43 respectively). Clearly emotional-motivational-temperamental aspects of development and functioning require continued research and continued attention by teachers and psychologists. In my own experience, many of the children with low reading rates for letters are children who have been relatively unhappy and often relatively disorganized in our preschool.

6. Scanning Speed: The ability to rapidly identify letters has been discussed. Related capacities for rapid serial identification or other tasks requiring eye-motor coordination over time may be related to reading capacity (e.g. catching balls, or cancellation tasks, and others). More able children may also be processing several items at once, even though no structural relations exist between them. The relationship between practice and maturational changes deserves attention. In general, I have found very little attention to studies of speed and speed training with beginning readers.

Conclusions: The Dangers of Ignoring Readiness

I began this paper with the suggestion that the age of readiness to learn to read might range from four to ten. (These might be approximate 3rd and 97th percentiles.) I chose the upper limit largely on the basis of my own observations of children in our laboratory school (Institute of Child Study, University of

Toronto). The lower limit is consistent with a good many studies.

The notion that some individuals are capable of mastering culturally important skills earlier than others is almost as unpopular in North American society as recognizing that some individuals are better endowed than others. Indeed, the two notions are closely linked since early development is frequently also better development. I have long suspected that awareness of this relationship explains much of the pressure for early reading along with many other skills.

Unfortunately, our demand for early development, and insistance that all children learn reading between six and eight, in fact may well retard both reading development and general ego growth. Being required to do what one does inadequately is almost as unpopular with children as it is with adults. We have known for a very long time - at least since the nineteen-twenties (Durkin, 1968) - that large numbers of children "fail" reading in first grade and that many continue to do so. This has been a cause of shame, embarrassment, and misery for large numbers of children, parents, and sometimes teachers. Our schools are filled with children who expect failure. Yet the proposition that much of this large amount of failure could perhaps be caused by nothing more than normal developmental differences in capacity to learn reading has rarely been entertained - at least by researchers.

Even those who are persuaded that maturation plays a role (e.g. de Hirsch et. al., Ausubel) tend to speak of "maturational lags", or delays when using such concepts to explain differences in reading functioning. Yet we would not usually refer to the ten percent of shortest children in a class as "lagging" in height or weight unless the conditions were extreme - perhaps below the 3rd percentile. However, as used in regard to reading, maturational "lags" are often treated as "deficits" requiring remedial instruction, rather than normal growth. No doubt, this is frequently the case. Yet much of the evidence presented in this

paper also suggests that the failures of many children may stem from no more serious cause than being on the wrong end of a normal distribution. Should renewed research on readiness support this view, perhaps I will be speaking to you a decade from now on Parent and Teacher Acceptance of Readiness Differences - A Major Research Problem for the Eighties.

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Abstract

Presents cross-sectional and longitudinal data relating the time required to read orally 50 unrelated letters, 50 unrelated words, and 100 words in text among first to sixth grade children and adults. Metropolitan Achievement Test Reading scale test scores are related to the time data. Results include concurrent correlations between letter, word, and text times ranging between .18 and .92 with a median of .77. Longitudinal correlations between grades two and six ranged from .21 to .96 with a median of .78 indicating a high level of developmental stability and strong relationships between the abilities to read letters or words rapidly at an earlier age and reading text rapidly at a later age. These results are interpreted on the basis that a common ability must be involved in the time required to read all three types of materials. Multiple regression analyses indicate that letter time variance is associated with a median of 46 percent of text time variance, while additional skills affecting word time variance is associated with a median of 27 percent of text time variance between grades two and six. Reading achievement scores are also highly associated with reading times both concurrently and longitudinally, with medians of 32 percent of letter time variance, 11 percent of additional word time variance, and 15 percent of additional text time variance being associated with M.A.T. reading score variance concurrently between grades two and six, while longitudinally, medians of 43 percent of grade two letter time variance, 7 percent of additional word time variance, and 26 percent of additional text time variance are associated with grade three or four reading comprehension score variances. These results are interpreted as indicating the existance of a developmental reading speed ability which is not primarily dependent on word identification or context-using skills. The nature of this ability and educational and research implications are discussed.